CLAIMS

1. Image sensing apparatus comprising:

at least one image pickup plate disposed generally laterally with respect to a direction of movement of an object; and

a plurality of image drive plates in spaced relation to said image pickup plate to define a plurality of sensor gaps, wherein features of the object passing over said sensor gaps produce a change in capacitance between respective image drive plates and said image pickup plate.

2. Image sensing apparatus as defined in claim 1, wherein said at least one image pickup plate and said plurality of image drive plates are dimensioned and spaced for sensing a fingerprint.

3. Image sensing apparatus as defined in claim 2, wherein a spacing between each of said image drive plates and said image pickup plate is less than about one half of the ridge spacing on a typical fingerprint.

4. Image sensing apparatus as defined in claim 2, wherein a spacing between adjacent ones of said image drive plates is less than about one half of the ridge spacing on a typical fingerprint.

5. Image sensing apparatus as defined in claim 1, wherein said image drive plates comprise parallel conductors disposed perpendicular to said image pickup plate and spaced from said image pickup plate by respective sensor gaps.

6. Image sensing apparatus as defined in claim 1, wherein said at least one image pickup plate comprises two or more image pickup plates disposed generally laterally with respect to the direction of movement of the object.

7. Image sensing apparatus as defined in claim 2, including at least about 250 image drive plates.

8. Image sensing apparatus as defined in claim 1, further comprising a substrate, wherein said at least one image pickup plate and said plurality of image drive plates comprise conductive traces on said substrate.

9. Image sensing apparatus as defined in claim 8, wherein said substrate comprises a printed circuit board.

10. Image sensing apparatus as defined in claim 8, wherein said substrate comprises a flexible substrate.

11. Image sensing apparatus as defined in claim 10, further comprising a substrate support, wherein said flexible substrate is affixed to said substrate support and wherein said substrate support has a contour selected to substantially match the contour of a typical finger.

12. Image sensing apparatus as defined in claim 1, further comprising:

an excitation circuit for sequentially energizing said image drive plates with drive signals, and

a detection circuit for detecting the drive signals capacitively coupled from said image drive plates to said image pickup plate to provide image signals.

13. Image sensing apparatus as defined in claim 12, wherein said drive signals comprise sequential signal bursts applied to respective ones of said image drive plates.

14. Image sensing apparatus as defined in claim 13, wherein said excitation circuit includes circuitry for coupling non-energized image drive plates to a reference potential.

15. Image sensing apparatus as defined in claim 13, wherein said signal bursts comprise bursts of a clock signal.

16. Image sensing apparatus as defined in claim 13, wherein said detection circuit comprises a synchronous detector for providing pulses in response to the detected signal bursts.

17. Image sensing apparatus as defined in claim 16, further comprising an analog-to-digital converter for converting said pulses to digital values, a memory and a processor for storing the digital values in said memory.

18. Image sensing apparatus as defined in claim 17, wherein said processor initiates a plurality of sequential line scans of said image drive plates to provide a plurality of line scans along lines of the moving object.

19. Image sensing apparatus as defined in claim 12, wherein said detection circuit includes an amplifier for receiving the capacitively coupled drive signals, said amplifier having a gain that is an inverse function of the amplitude of the capacitively coupled drive signals.

20. Rate sensing apparatus comprising:

two or more object detectors spaced apart along a direction of movement of an object, each of said object detectors including at least one rate drive plate and at least one rate pickup plate, wherein an end of an object passing over each of said object detectors produces a change in capacitance between respective rate drive plates and rate pickup plates.

21. Rate sensing apparatus as defined in claim 20, wherein the rate drive plate and the rate pickup plate of each of said object detectors are disposed generally laterally with respect to the direction of movement of the object.

22. Rate sensing apparatus as defined in claim 20, wherein the rate pickup plates of said sets of rate sensing plates are commonly connected.

23. Rate sensing apparatus as defined in claim 20, wherein each of said object detectors includes first and second rate pickup plates disposed on opposite sides of the rate drive plate to form a differential rate sensor.

24. Rate sensing apparatus as defined in claim 23, wherein the rate drive plates of said object detectors are commonly connected.

25. Rate sensing apparatus as defined in claim 20, wherein the rate drive plates and the rate pickup plates of said object detectors are dimensioned and spaced for detecting the speed of a moving finger.

26. Rate sensing apparatus as defined in claim 25, wherein the rate drive plates and the rate pickup plates of said object detectors are curved to substantially match the curve of a typical finger end.

27. Rate sensing apparatus as defined in claim 25, further comprising a substrate, wherein said rate drive plates and said rate pickup plates comprise conductive traces on said substrate.

28. Rate sensing apparatus as defined in claim 20, further comprising a flexible substrate, wherein said rate drive plates and said rate pickup plates comprise conductive traces on said flexible substrate.

29. Rate sensing apparatus as defined in claim 27, wherein said substrate comprises a printed circuit board.

30. Rate sensing apparatus as defined in claim 20, further comprising:

an excitation circuit for energizing the rate drive plates of said object detectors with drive signals, and

a detection circuit for detecting the drive signals capacitively coupled from the rate drive plate to the rate pickup plate of each of said object detectors to provide rate signals.

31. Rate sensing apparatus as defined in claim 30, wherein said drive signals comprise signal bursts.

32. Rate sensing apparatus as defined in claim 31, wherein said signal bursts comprise bursts of a clock signal.

33. Rate sensing apparatus as defined in claim 31, wherein said detection circuit comprises a synchronous detector.

34. Rate sensing apparatus as defined in claim 30, further comprising a processing circuit for determining a time delay between said rate signals from said object detectors, wherein said time delay between said rate signals is representative of a speed of the object.

35. A fingerprint sensing system comprising:

an image sensor comprising a linear array of capacitive sensors for capacitive sensing of ridge peaks and ridge valleys of a fingerprint on a moving finger;

a rate sensor for sensing a speed of the finger as it moves across said image sensor; and

a sensor circuit for excitation of said image sensor with image drive signals and for detection of image signals in response to said image drive signals, for excitation of said rate sensor with rate drive signals and for detection of rate signals in response to said rate drive signals, and for coordinating said image signals and said rate signals to provide a fingerprint image.

36. A fingerprint sensing system as defined in claim 35, wherein said image sensor comprises:

at least one image pickup plate disposed generally laterally with respect to a direction of movement of the finger; and

a plurality of image drive plates in spaced relation to said image pickup plate to define a plurality of sensor gaps, wherein ridge peaks and ridge valleys of the fingerprint

passing over said sensor gaps produce a change in capacitance between respective image drive plates and said image pickup plate.

37. A fingerprint sensing system as defined in claim 36, wherein a spacing between each of said image drive plates and said image pickup plate is less than about one half of the ridge spacing on a typical fingerprint.

38. A fingerprint sensing system as defined in claim 36, wherein a spacing between adjacent ones of said image drive plates is less than about one half of the ridge spacing on a typical fingerprint.

39. A fingerprint sensing system as defined in claim 36, wherein said image drive plates comprise parallel conductors disposed perpendicular to said image pickup plate and spaced from said image pickup plate by respective sensor gaps.

40. A fingerprint sensing system as defined in claim 36, wherein said at least one image pickup plate comprises two or more image pickup plates disposed generally laterally with respect to the direction of movement of the finger.

41. A fingerprint sensing system as defined in claim 36, including at least about 250 image drive plates.

42. A fingerprint sensing system as defined in claim 36, further comprising a substrate, wherein said at least one image pickup plate and said plurality of image drive plates comprise conductive traces on said substrate.

43. A fingerprint sensing system as defined in claim 42, wherein said substrate comprises a flexible substrate.

44. A fingerprint sensing system as defined in claim 43, further comprising a substrate support, wherein said flexible substrate is affixed to said substrate support and

wherein said substrate support has a contour selected to substantially match the contour of a typical finger.

45. A fingerprint sensing system as defined in claim 36, wherein said sensor circuit comprises:

an excitation circuit for sequentially energizing said image drive plates with said image drive signals, and

a detection circuit for detecting the image drive signals capacitively coupled from said image drive plates to said image pickup plate to provide said image signals.

46. A fingerprint sensing system as defined in claim 45, wherein said image drive signals comprise sequential signal bursts applied to respective ones of said image drive plates.

47. A fingerprint sensing system as defined in claim 46, wherein said excitation circuit includes circuitry for coupling non-energized image drive plates to a reference potential.

48. A fingerprint sensing system as defined in claim 46, wherein said detection circuit comprises a synchronous detector for providing pulsed image signals.

49. A fingerprint sensing system as defined in claim 48, wherein said sensor circuit further comprises an analog-to-digital converter for converting said pulsed image signals to digital values, a memory and a processor for storing the digital values in said memory.

50. A fingerprint sensing system as defined in claim 49, wherein said processor initiates a plurality of sequential line scans of said image drive plates to provide a plurality of line scans along lines of the moving finger.

51. A fingerprint sensing system as defined in claim 45, wherein said detection circuit includes an amplifier for receiving the capacitively coupled image drive signals,

said amplifier having a gain that is an inverse function of the amplitude of the capacitively coupled image drive signals.

52. A fingerprint sensing system as defined in claim 35, wherein said rate sensor comprises:

two or more finger detectors spaced apart along a direction of movement of the finger, each of said finger detectors including at least one rate drive plate and at least one rate pickup plate, wherein an end of the finger passing over each of said finger detectors produces a change in capacitance between respective rate drive plates and rate pickup plates.

53. A fingerprint sensing system as defined in claim 52, wherein the rate drive plate and the rate pickup plate of each of said finger detectors are disposed generally laterally with respect to the direction of movement of the finger.

54. A fingerprint sensing system as defined in claim 52, wherein the rate pickup plates of said finger detectors are commonly connected.

55. A fingerprint sensing system as defined in claim 52, wherein each of said finger detectors includes first and second rate pickup plates disposed on opposite sides of the rate drive plate to form a differential capacitive sensor.

56. A fingerprint sensing system as defined in claim 55, wherein the rate drive plates of said finger detectors are commonly connected.

57. A fingerprint sensing system as defined in claim 52, wherein the rate drive plates and the rate pickup plates of said finger detectors are curved to substantially match the curve of a typical finger end.

58. A fingerprint sensing system as defined in claim 52, further comprising a substrate, wherein said rate drive plates and said rate pickup plates comprise conductive traces on said substrate.

59. A fingerprint sensing system as defined in claim 52, further comprising a flexible substrate, wherein said rate drive plates and said rate pickup plates comprise conductive traces on said flexible substrate.

60. A fingerprint sensing system as defined in claim 52, wherein said sensor circuit comprises:

an excitation circuit for energizing the rate drive plates of said finger detectors with said rate drive signals, and

a detection circuit for detecting the rate drive signals capacitively coupled from the rate drive plate to the rate pickup plate of each of said finger detectors to provide said rate signals.

61. A fingerprint sensing system as defined in claim 60, wherein said rate drive signals comprise signal bursts.

62. A fingerprint sensing system as defined in claim 61, wherein said detection circuit comprises a synchronous detector.

63. A fingerprint sensing system as defined in claim 60, wherein said sensor circuit further comprises a processing circuit for detecting a time delay between said rate signals from said finger detectors, wherein said time delay between said rate signals is representative of the speed of the finger.

64. A fingerprint sensing system as defined in claim 35, further comprising a substrate, wherein said image sensor and said rate sensor are fabricated on said substrate.

65. A fingerprint sensing system as defined in claim 64, wherein said substrate comprises a flexible substrate.

66. A fingerprint sensing system as defined in claim 64, wherein said sensor circuit is mounted on said substrate.

67. A fingerprint sensing method, comprising the steps of:

capacitively sensing ridge peaks and ridge valleys of a fingerprint on a swiped finger with a linear array of capacitive sensors and providing image signals representative of a line of the fingerprint; and

acquiring from the linear array of capacitive sensors image signals representative of multiple lines of the fingerprint to provide a fingerprint image.

68. A fingerprint sensing method, comprising the steps of:

capacitively sensing ridge peaks and ridge valleys of a fingerprint on a swiped finger with a linear array of capacitive sensors and providing image signals;

sensing a speed of the finger as it is swiped across the linear array of capacitive sensors and providing rate signals; and

coordinating the image signals and the rate signals to provide a fingerprint image.

69. Image sensing apparatus as defined in claim 1, wherein said at least one image pickup plate and said plurality of image drive plates are substantially coplanar.

70. Rate sensing apparatus as defined in claim 20, wherein the rate drive plate and the rate pickup plate of each of said object detectors are substantially coplanar.

71. A fingerprint sensing system as defined in claim 36, wherein said at least one image pickup plate and said plurality of drive plates are substantially coplanar.

72. A fingerprint sensing system as defined in claim 52, wherein the rate drive plate and the rate pickup plate of each of said finger detectors are substantially coplanar.

73. A capacitive sensor comprising:

at least one pickup plate; and

a plurality of drive plates in spaced relation to said pickup plate to define an array of sensor gaps, said pickup plate and said plurality of drive plates being substantially

coplanar, wherein an object passing above said array of sensor gaps produces a change in capacitance between respective drive plates and said pickup plate.

74. A capacitive sensor as defined in claim 73, wherein said pickup plate and said plurality of drive plates comprise conductive traces on a substrate.

75. A capacitive sensor as defined in claim 74, wherein said substrate comprises a flexible substrate.

76. A capacitive sensor as defined in claim 73, wherein said pickup plate and said plurality of drive plates are dimensioned and spaced for sensing a fingerprint.

77. A capacitive sensor as defined in claim 73, wherein said array of sensor gaps comprises a linear array.

78. A capacitive sensor as defined in claim 76, wherein said sensor gaps have dimensions of about 25 to 50 micrometers.